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THE CHINESE IMPERIAL SPRING PLOWING

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South of Peking, perhaps a half-hour's ride by riksha, is the Temple of Agriculture. It is really a park comprising between three and four hundred acres with a boundary of about two miles. In the days of the Empire four altars, buildings of some size, were in the grounds; one was dedicated to Heaven, one to Earth, one to Jupiter, and the most important one to Shenung, the "Divine Laborer". Legend tells that Emperor Shen-nung fashioned the first plowshare and taught the people of China how to use it. This was some five thousand years ago.

In the early spring in this Temple of Agriculture, the Agricultural Festival, or Imperial Plowing Ceremony was solemnly observed for centuries. On the chosen day, designated each year by Imperial decree, the Emperor, clad in farmer's garb, of yellow, the Imperial color, proceeded to the temple, attended by officials, ministers, and members of the royal family, all dressed as farmers. In the sacred field in the Temple, the Emperor with an elaborately ornamented plow kept for this purpose plowed three furrows. The princes then plowed five furrows and the ministers nine. In the latter days of the Manchu rule the Imperial number of furrows was changed to four. The plot plowed by the Emperor was never profaned by being touched by other than the Heaven-Chosen Imperial hands.

When the plowing was finished, His Imperial Majesty, the princes, and the ministers repaired to a terrace near by, where they stayed until the field was all plowed. The ceremony was not public. No audience was admitted to gaze upon the turning of the soil by royal hands.

After the plowing, prescribed rites of worship were performed at each of the four altars. These rites were of homage, not of atonement.

The grain (wheat in this north land), harvested from the Imperial plot was stored in yellow sacks and used in worship at the ancestral tombs of the Emperor.

Throughout the Empire, the Agricultural Festival was observed by Imperial order. Provincial and municipal officials arranged ceremonies of various kinds, all tending to elevate farming and to propitiate the gods controlling the yield of the earth.

The origin of the Festival appears to be lost in the mythical mazes of antiquity. It is claimed that it originated with Emperor Chan, 2300 B. C. The claim has some reason, as Emperor Yao selected Chan as his successor because of his superior skill and success in farming. In the centuries succeeding Chan's reign the Emperors paid much attention to the fostering and progress of agriculture. When this interest in soil cultivation lagged in the rulers, prosperity dwindled.

The occupant of the Dragon throne in the second century before the Christian Era was so distressed about the condition of agricultural production that he called a council to discuss the remedies. The council agreed that more attention to the cultivating and planting of the soil was the only thing necessary to restore prosperity. The Emperor set the example by cultivating with his own hands land belonging to the Imperial Palaces. Mandarins and officials were commanded to follow royalty's example. This, probably, was the origin of the Imperial plowing in the Temple of Agriculture near Peking.

As evidenced by this presumed origin, the Imperial spring plowing in the Temple of Agriculture, though performed with solemnity and royal dignity, was not really a religious act, nor was it in any way an act of superstition. The object was to place and to hold tilling of the soil in China as the most honorable labor; the Sacred and Mighty Emperor himself, not disdaining to hold the plow and turn the furrow. Says an ancient Chinese writer: "Agriculture holds the first place among the branches of labor and the honors paid to it by the annual plowing ceremony are given from a deep sense of its importance to the public welfare."

In the provincial Agricultural Festivals a popular maxim among those on banners carried in the parades was, "The horse's back is not so safe as the water buffalo's." The interpretation is, "The politician is not so secure as the farmer."

About the middle of the last century the Emperor then in power in the splendid yellow-tiled Forbidden City in Peking, in his interviews with provincial officials who came to the capital, questioned them far more closely as to the condition of crops than about political conditions. Viceroys were commanded to note with carè the most successful and progressive farmers. One favorably reported upon was rewarded by being raised to a mandarin of the eighth order. He could wear the robe of a mandarin, visit the governor, and drink tea with him. He would be given dignified obsequies at death. Antecedent to this period, a law was promulgated by royal decree giving the Emperor the right to confiscate all neglected or uncultivated fields and grant them to industrious farmers under rules requiring their being properly farmed.

The last ruler of the Celestial Empire to plow the Imperial Plot was Kuang Hsu, the unfortunate victim of the vaulting ambition and conservatism of the Empress Dowager, "Old Buddha." Kuang Hsu was a generation or more ahead of the times in his ideas and ideals. That was his misfortune in that it cost him his throne, liberty, and finally his life. But in his brief period of power he did more for agriculture than to plow his four furrows. He decreed the establishment of agricultural schools in each province where farmers were to be taught modern methods of farming. True, his decree was not carried out but it had some influence; the seed was not all destined to fall upon barren soil.

Today, the Temple of Agriculture is a recreation park, open to any one who pays the nominal admission charge. It is not a park given over to noisy diver-

sions, not by any means. It is truly a place for rest and recreation. The splendid trees are preserved and new ones of many varieties as well as interesting and beautiful shrubs are being planted. One altar is set aside for agricultural exhibits. Other buildings are transformed into pleasant pavilions where many cups of amber tea may be drunk and salted watermelon seeds and nuts of many kinds be nibbled.

As a point, not so much of importance as that it sweeps into the hurly burly of the present this old Temple dedicated to honoring that which underlies national greatness, is its association with the Boxer siege of the Foreign Legations in 1900. Under the shade of its age-old trees, bivouacked the American soldiers of the relief forces. Some two or three miles away their British cousins camped in the magnificently forested grounds of the Temple of Heaven and the Altar of Heaven, the latter unparalleled for conception of beauty and expression of worship among the temples of the world.

I firmly believe that science and peace will triumph over ignorance and war and that nations will combine, not to destroy but to build up.—*Pasteur.*

It is a part of the function of every progressive institution of learning, not only to impart knowledge to students, but to do its share in accumulating knowledge for the benefit of mankind.—*Leroy D. Weld.*

BANANA STEM AND FRUIT ROT[1]

By JULIAN A. AGATI

The banana is a wholesome fruit which abounds in the tropics and subtropics. Like other agricultural crops which are grown on a large scale in localities, the banana develops diseases and pests. Some of these diseases are so destructive, that, for successful banana culture, attention must be given them.

Throughout the American tropics bananas ripen prematurely. When this happens a rotting due to fungi generally occurs. The most common of these fungi is *Gloeosporium musarum* Cooke and Massee (1).

In Queensland, Australia, south-east Africa, and particularly in India, although spraying work was done by Dastur (2) in India, the banana fruit is badly affected by this fungus. In these places it is reported that entire plantations were destroyed.

In Australia, Cobb (3) reported that besides *Gloeosporium musarum* Cooke and Massee another species was also found on apples, pears, quinces, tomatoes, eggplants, and guavas.

Some years ago, Morris (4) studied *Gloeosporium musarum* Cooke and Massee, and reported that in Jamaica and in Trinidad, the stem as well as the fruit was infected.

The fungus seems to be widely spread in tropical countries and a thorough study of it and of measures for its control are of great importance.

The object of the present work was to study the organism causing the fruit and stem rot of banana; its behavior in culture and in nature; the extent of damage that it does to the different varieties of banana; its mode of living and the method by which it is spread in nature as well as the manner of infection, with a view of adopting measures to check or reduce the disease that it produces.

The work was conducted both in the field and in the laboratory of the College of Agriculture, from June, 1919, to March, 1921, a period of about two years. The College plantation consisting of different varieties of both native and foreign bananas, planted side by side, afforded abundant material for the observation of the occurrence and severity of the disease as well as the relation of the fungus to the different varieties.

ECONOMIC IMPORTANCE

Observation of the damage produced by the disease was made in the College plantation and in neighboring banana fields. In going through the rows of the different varieties of bananas, the writer observed many bunches affected by the disease (approximately 15.62 per cent). All of these affected bunches were collected for microscopic examination and cultural studies in the laboratory. It

[1] Thesis presented for graduation from the College of Agriculture, No 138, Experiment Station contribution No. 81.

was observed that in all cases the fungus was a species of *Gloeosporium*. Subsequent observations showed that some of the varieties that did not show infection at first were susceptible to the fungus.

In private banana plantations it was found that the fungus was likewise prevalent on certain varieties, such as Boñgolan, Lacatan, Sabang Iloco, and Butuan.

Field observations showed that the varieties tabulated in Table I were susceptible to the disease.

TABLE I.—*Varieties of bananas infected in the field.*

College number.	Variety name.	
5190	Grang or Kluay Nark	foreign
4979	Lacatan	native
5000	Butuan	native
5028	Musa Cantong	foreign
5357	Paranan	native
5004	New Guinea Sugar	foreign
5381	Kanher	foreign
5252	Fique Blanche	foreign
5380	Yanaikohan	foreign
5059	Yale bale	foreign
5177	Indung soo	foreign
5397	Klin Phaya Soo	foreign
4984	Dool	foreign
4977	Boñgolan	native
303	Cavendish	foreign
5028	Inambak	foreign
5178	Ideep	foreign
5118	Musa Dulong	foreign
5141	Kowloon Huaam	foreign
5085	Tindoc	foreign
5033	Martaban	foreign
5669	Poriquit	foreign
5248	Doraya	foreign
5181	Hum chuntura	foreign
5203	You Vot ching	foreign
5181	Num chung Lai	foreign
5036	Sabang Iloco	native
2800	Tarnate	native
306	Morado	native
1116	Tudlong dato	native

As shown by Table I most of the infected varieties were foreign. The table also shows that among the native varieties with the exception of Butuan, Tudlong dato, and Sabang Iloco, the sweet ones were the most susceptible, particularly the Lacatan, Boñgolan, Paranan, Morado, and Tarnate.

The fungus was found not only on immature fruit, but frequently on mature fruit in storage. It was observed that it was not safe to keep susceptible varieties like the Lacatan, Boñgolan, Tarnate, Sabas, all eating bananas, too long. Storing mature fruits which had old flowers, especially if they were bruised on the skin or on other parts, favored the disease. It was also observed that moist places were favorable to the growth and development of the fungus. When the fruit was infected, the organism covered the entire fruit completely in a short time and produced a sour taste in the meat and a characteristic odor, resembling that given off from fermenting alcohol. If the infected fruit is stored it rots and its market value is lowered.

SYMPTOMS

EARLY STAGE OF INFECTION

The presence of the disease is indicated by small black circular specks usually found on the skin, distal ends of the "hands," and on the flowers. These spots increase in size and advance towards the "hands," then to the petiole and finally to the handle.

ADVANCED STAGE OF INFECTION

In the advanced stage of the disease, the specks become sunken, merging into one another, forming larger spots. These, in cases of serious infection, may cover the entire fruit. In these confluent dead and sunken areas there develop characteristic red, bright, moist groups of spores, which later dry and harden. Infected fruits are observed to ripen prematurely, to finally turn black and rot. The stalk becomes stunted and dry, and the leaves droop and shrivel up.

EXPERIMENTS AND RESULTS

METHODS OF ISOLATING THE CAUSAL ORGANISM

In order to grow the fungus in artificial media, a fresh specimen which developed a typical case of the disease was obtained. It was carefully washed with water and then sterilized by immersing in mercuric chloride solution (1:1000) for from forty-five seconds to one minute. Then it was washed with sterilized water to remove the disinfectant.

With a flamed scalpel sterilized cuttings were made from the portion where the disease was farthest advanced. The first cuttings were thrown away and only the subsequent sections saved. The scalpel was disinfected after each cut. The cuttings were plated out on potato agar. After a day's growth was produced, the portions of the mycelium were transferred to agar slants.

The fungus was isolated also by directly plating out diseased sections without sterilization. Besides plating the diseased tissue, the red moist growths were plated directly without sterilization on potato agar plates. In all cases the typical growths of *Gloeosporium musarum* were obtained.

ARTIFICIAL INFECTION EXPERIMENTS

When the organism was growing in pure culture inoculation experiments were made to test whether the fungus would cause the same trouble on banana. In this work, a series of experiments were carried on both in the field and in the laboratory. All possible precautions were taken to prevent contamination.

On September 14, 1919, eight sound mature fruits were inoculated using Culture I on the first three, and Culture II on the rest.

The fruits were disinfected with mercuric chloride solution (1:1000) and after ten minutes were rinsed with three changes of sterilized water. Small pricks were made on the fruits with a sterilized sharp-pointed scalpel, and bits of mycelium of the organism used were inserted into the pricks by means of a sterilized platinum needle. Control fruits were maintained in which all the other treatments were made except the addition of mycelium. The results are shown in Table II.

As shown in Table II the eight fruits inoculated, except the controls, were infected. This was shown by the longitudinal blackening of the portion surrounding the pricks and the moist appearance of the pricks. Subsequent observations in which moist spores were observed confirmed the infection. It was observed that some of the varieties used, such as Binaoy, Inambac, Manubaga, and Pinagbilinan showed resistance to the disease; while in Lacatan, Ideep, Radja Molacca

TABLE II.—*Inoculation through injuries.*

Culture number.	Age.	Date of inoculation.	Host inoculated.	Observations.	
				Date of infection.	Degree of infection.
	days				
1	11	Sept 14, 1919 ..	Ideep.....	Sept 24, 1919...	Readily infected
1	11	Sept 14, 1919...	Binaoy.....	Oct 1, 1919.....	Less infected
1	11	Sept 14, 1919...	Lacatan.....	Sept 20, 1919...	Readily infected
2	24	Sept 27, 1919...	Inambak.....	Oct 22, 1919....	Less infected
2	24	Sept 27, 1919...	Radja Molacca .	Oct 6, 1919.....	Readily infected
—2	24	Sept 27, 1919...	Saba.....	Oct 6, 1919.....	Readily infected
2	24	Sept 27, 1919...	Manubaga	Oct 20, 1919....	Less infected
2	24	Sept 27, 1919...	Pinagbilinan....	Oct 23, 1919....	Less inefcted

and Saba, the disease developed in a comparatively short time. The fruits may be divided into two classes; those readily infected and those less readily infected. The range in the date of infection in the former was six to ten days, and in the latter, fifteen to twenty-three days. The causal organism was re-isolated and was found to be identical with the original fungus.

On September 27, 1919, six different varieties were inoculated, and on November 7, three others were inoculated with Culture III.

Following the precautions observed in the first series of experiments, the fruits were sprayed with spores of the organism, suspended in sterilized water. Table III gives the results of the experiment.

TABLE III.—*Inoculation of mature fruits by spraying through injuries.*

Culture number.	Age.	Date of inoculation.	Host inoculated.	Observations.	
				Date of infection.	Degree of infection.
	days				
2	24	Sept 27, 1919 ..	Doraya	Oct 6, 1919	Readily infected
2	24	Sept 27, 1919 ..	Dool.....	Oct. 8, 1919.....	Readily infected
2	24	Sept. 27, 1919...	Klin Phaya Sao .	Oct. 8, 1919.....	Readily infected
2	24	Sept. 27, 1919...	Yale bale.....	Oct. 20, 1919....	Less infected
2	24	Sept. 27, 1919...	Litungdan.....	Oct. 20, 1919....	Less infected
3	24	Nov. 7, 1919....	Hamakua.....	Nov. 27, 1919...	Less infected
3	24	Nov. 7, 1919....	Kinabansi.....	Nov. 26, 1919...	Less infected
3	24	Nov. 7, 1919....	Nark.....	Nov. 24, 1919...	Less infected

It was found that, first there was a longitudinal blackening of the portions surrounding the pricks; following this, there appeared a watery ring about the pricks. The existence of infection was confirmed by the formation of characteristic red, moist groups of spores on and around the infected pricks.

Of the varieties inoculated except the controls, the varieties such as Doraya, Dool, Klin Phaya Sao, and Nark showed infection in a comparatively short time, while the other varieties such as Yale bale, Litungdan, Hamakua, and Kinabansi showed a degree of resistance to the disease. The range in the date of infection among the readily infected fruits was nine to eleven days while that of the less infected ones was fifteen to twenty-three days.

The causal organism was re-isolated and it was found that it was identical with the original culture used.

On February 24, 1920, seven different varieties were inoculated with Cultures III, IV, and V. On March 3, 1920, seven other varieties were inoculated, using Culture V, only. On April 15, two different varieties were inoculated with Cultures VI and VII respectively, and on May 5, two different ones were inoculated using Cultures VIII and IX respectively.

In this series of experiments, mature as well as young fruits, including the inflorescence were sprayed. The results are shown in Table IV.

TABLE IV.—*Inoculation of mature and young fruits including flowers through injuries with spore suspension.*

Culture number.	Age.	Date of inoculation.	Host inoculated.	Observations.	
				Date of infection.	Degree of infection.
	days				
3	11	Feb. 24, 1920.....	Suñgay baca....	March 9, 1920..	Readily infected
4	11	Feb. 24, 1920.....	M. Paradisiaca..	March 1, 1920...	Readily infected
4	11	Feb. 24, 1920....	Martaban Dacca	March 9, 1920...	Readily infected
4	11	Feb. 24, 1920.....	Pisang Radja...	March 6, 1920...	Readily infected
4	11	Feb. 24, 1920.....	Daryao.....	March 6, 1920...	Readily infected
5	20	Feb. 24, 1920.....	Morado.....	March 1, 1920...	Readily infected
5	20	Feb. 24, 1920.....	Pitogo.....	March 4, 1920..	Readily infected
5	20	March 3, 1920....	Musa nangka...	March 20, 1920..	Less infected
5	20	March 3, 1920....	Musa Omata....	March 23, 1920..	Less infected
5	20	March 3, 1920....	Lotondan.....	March 27, 1920..	Less infected
5	20	March 3, 1920....	Ruswell.....	March 19, 1920..	Less infected
5	20	March 3, 1920....	Tudlo Dalaga...	March 20, 1920..	Less infected
5	20	March 3, 1920....	Musa Cantong..	March 13, 1920..	Readily infected
5	20	March 3, 1920....	Naleong	March 26, 1920..	Less infected
6	10	April 15, 1920.....	Sabang Iloco....	April 25, 1920...	Readily infected
7	10	April 15, 1920....	Cavendish.....	April 26, 1920...	Readily infected
8	10	May 5, 1920.....	Boñgolan.....	May 10, 1920...	Readily infected
9	10	May 5, 1920.....	Butuan.....	May 13, 1920...	Readily infected

Subsequent observations on the second set of inoculations revealed that with the exception of the controls the seven varieties showed the development of the disease.

Six of these varieties seemed to be less infected; the range in the date of infection was from sixteen to twenty-three days. The one variety which was readily infected showed signs of infection on the tenth day.

All the re-isolations made were positive.

Observations on the last two sets of inoculations showed the seemingly susceptible condition of the varieties used. All of the four varieties were readily infected and showed a range of five to eleven days in the date of infection. In all cases positive re-isolations were obtained.

MORPHOLOGY

To obtain an idea of the fungus, drawings of the mycelium, conidiophores, and conidia were made under the high power of the microscope with a camera lucida. The specimens used were both from pure cultures on potato agar slants and from typical natural infections.

Acervuli.—Pink concentric rings are formed in which spores were embedded. These rings burst out and grow in clusters.

Mycelium.—In general, the mycelium of all the cultures examined grow abundantly in masses. Microscopic examinations revealed it to be hyaline and non-septate.

Conidiophores.—The conidiophores are rather difficult to distinguish as the conidia are seldom found attached to them. The spores seem to separate before they mature. The conidia are borne singly and apically on rather long branching conidiophores. The conidiophores rise from the abundantly packed mycelia.

Conidia.—The spores are hyaline, generally elongated, ellipsoid, and rounded at the ends. They are thin-walled and granular within. They vary in size and in shape. The young ones are more rounded than the old ones. The germ tube generally arises from one of the ends of the spores. The spores germinate rapidly

TABLE V.—*Measurement of spores.*

Class.	Length.	Width.
microns		
3.5 to 5.49.....	——	53
5.5 to 7.49.....	——	144
7.5 to 9.49.....	——	3
9.5 to 11.49.....	——	——
11.5 to 13.49.....	19	——
13.5 to 15.49.....	101	——
15.5 to 17.49.....	80	——
17.5 to 19.49.....	——	——
TOTAL.....	200	200

in a drop of water, but if the water is removed the spores perish quickly. If abundantly packed masses of spores are sown in water, they will germinate more slowly.

Spore measurement.—Spore measurements were made from the representative pure cultures. The length and width of two hundred spores were taken The measurements are given in Table V.

As shown by Table V, the lengths of one hundred and one of the spores fell under the class 13.5 microns to 15.49 microns, and only nineteen under the class 11.5 to 13.49 microns.

As regards the measurements of the width, one hundred forty-four spores belong to the class 5.5 to 7.49 microns, fifty-three belong to the class 3.5 to 4.59 microns, and only three belong to the class 7.5 to 9.49 microns.

PHYSIOLOGY

A study of the growth of the fungus on different media was made in the laboratory. Observations were made daily for a week and then weekly for about two months.

Growth on potato agar.—On July 3, 1920, bits of mycelium of equal sizes were transferred on to potato agar slants by means of a sterilized platinum needle. It was found necessary for purposes of comparison to transfer nearly the same amount of mycelium in all cases.

After a day, it was found that the mycelium grew radially, appearing like a cottony white growth and covered an area of one-half centimeter on the surface of the slanted medium. In two days, the entire surface was covered and red clusters of spores began to develop. In eight days the clusters of spores turned brown and in about three weeks the potato agar slants were shriveled. The mycelium became dark brown, and finally turned gray.

Growth on sterilized banana flowers.—On July 3, 1920, bits of mycelium were transferred on to the sterilized banana flowers. After two days it was found that a cottony white growth began to develop. In five days it became dense and covered nearly the entire surface of the medium. Spores began to form in clusters which gradually turned dark brown. In about four weeks the mycelium became dense, turned gray, and was almost black at the center of the medium.

Growth on sterilized banana fruits.—On July 3, 1920, bits of mycelium were transferred to sterilized banana fruits. It was found that after two days the mycelium developed into a cottony white growth. After five days the mycelium covered almost the entire surface of the fruit. A few days later numerous moist groups of spores began to develop. They gradually became dark brown in color. The mycelium grew thick and gradually became gray.

Growth on sterilized banana fruit cylinder.—Bits of mycelium were transferred on to the medium. It was found that in one day the mycelium grew radially, developing into a cottony white growth. Two days later the mycelium covered almost the entire surface of the medium. Numerous spores began to develop which gradually turned darker as they became older. The mycelium grew thicker and became grayish black.

Growth on sterilized banana stem heart.—The organism germinated on the third day after the transfer. The mycelium did not develop to a great extent. In a week the spores began to form, but were not so abundant as those developed on the other media.

Growth on rice agar.—The second day after the transfer of the organism, the mycelium began to develop and a white circular growth was produced on the agar. The mycelium was not dense, but numerous spores were formed. Both mycelium and spores gradually turned dark brown, then grayish black.

Growth on oat agar.—On the next day after the transfer the mycelium began to develop into a cottony white growth. The growth here was very similar to that produced on potato agar. In three to five days spores began to develop abundantly. In the later stage, the mycelium, as well as the spores, turned dark brown then gray.

Growth on glucose.—The day following the transfer, the organism germinated and produced a circular white growth on the medium. On the following day the exposed surface of the medium was covered by the fungus. The mycelium was very dense and the spores numerous. They gradually became very dark brown and turned almost black.

Growth on corn meal.—The organism germinated the day following the transfer and developed a circular white growth on the surface of the medium. The mycelium was not so dense as in the other media, but the spores were very numerous and were bright red. The clusters of spores appeared darker in color as they became older.

TAXONOMY

In the microscopic examination of the organism, with regard to form, structure, and color, it was found that the description of the spores, with a slight difference in the size, conforms closely to the description made by Stevens (5) and Cooke (6).

The description of the organism made by Stevens and Cooke is quoted:

"Pustules innate, erumpent, gregarious, rather rosy. Conidia elongated, ellipsoid, rounded at the ends, continuous, hyaline 10—12 x 4 microns, granular within."

SPORE DISSEMINATION AND METHOD OF HIBERNATION

It was observed that the disease was disseminated principally by spores. The spores are mainly conveyed to hosts by wind and in some cases insects while moving from flower to flower. Under favorable conditions the spores germinate rapidly and develop abundant mycelia. The mycelia develop numerous spores which continue the life cycle of the organism.

Spore-catching experiments.—Spore-catching experiments were carried on in the plantation. For this purpose five stakes, each one meter long, were set at different places in such a way that the first was under the bunch, the second, one meter away from it, the third one and a half meters away, the fourth, two meters, and the last, exactly three meters away. A plate of agar was placed on top of each stake. The stakes were set so as to form a line following the direction of the wind.

After a day or so, the plates were collected, labeled, and kept in the laboratory. On the following day a cottony white growth began to develop from the reddish brown structures which stuck to some of the plates when they were exposed. Numerous different fungi also developed on the agar. The following morning transfers were made from the cottony white growth and a culture was made on potato agar slants. Upon examination, it was found that the organism was identical with the pure cultures of *Gloeosporium musarum.*

DISCUSSION OF RESULTS

In the inoculation experiments, to find out the chief source of infection it was thought best to infect the mature fruits as well as the young ones including the inflorescence.

The results of the first series of inoculations wherein only mature fruits were used are summarized in Table II. It was observed that all the fruits were infected by the fungus, although there was variation in the date of infection. Ideep, Lacatan, Radja Molacca, and Saba were infected early while Binaoy, Inambak, Mambaja, and Pinagbilinan were infected much later.

The nature of rots produced on all the hosts was identical in every respect. The longitudinal blackening around the infected pricks and the moist appearance of the pricks were the main characteristics of the rots.

Table III shows the results of spraying mature fruits that have been injured. Subsequent observations showed that the organism was able to cause rots on all the hosts although there was a slight difference in the extent of infection. The varieties Doraya, Dool, Klin Phaya Sao, and Nark were readily infected while the varieties Yale bale, Litungdan, Hamakua, and Kinabansi were less infected. Only one general type of rot was produced on all the hosts.

In Table IV are summarized the results of spraying the mature fruits as well as the young ones including the inflorescence with spores from a pure culture of the fungus. Consecutive observations showed the production of typical rots which were characteristic of the disease. The length of time required to bring out the rot varied slightly. The varieties Suñgay baca, M. Paradisiaca, Martaban Dacca, Pisang Radja, Daryao, Morado, Pitogo, Ruswell, Tudlo Dalaga, Musa Cantong, Sabang Iloco, Cavendish, Boñgolan and Butuan were infected early while Musa Nangka, Musa Omata, Lotondan, and Nale Ong were infected much later.

Moisture was found to be favorable for the proper and rapid development of the disease. During rainy days the inoculations developed rapidly and field infections were also prevalent.

The individuality and age of the fruit seem to account for the propensities to infection. Sweet, immature varieties readily succumbed to the disease while mature varieties which were not so sweet showed a slight degree of resistance. It was also observed that inflorescences readily harbor the disease. It appears that the inflorescence is one of the chief means of field infection.

SUMMARY OF CONCLUSIONS

1. Fruit rots caused by *Gloeosporium musarum* are prevalent on the College and outside banana plantations.

2. Fruit stored in damp places was easily infected especially when the fruit was bruised on the peel and on the handle. This bruising is prevalent on outside plantations where the planters pile up the harvested fruit prior to marketing it.

3. *Gloeosporium musarum* attacks different varieties of banana in the College and on outside plantations. About 30 varieties were found actually harboring the fungus.

4. The characteristic rot was reddish brown, turning black as it became old, and showing the presence of characteristic reddish-brown clusters of spores which later turned gray. The diseased fruit dried, hardened, and shriveled.

5. It was found that all the cultures used produced the disease through wounds.

6. Mature as well as immature fruit was attacked by the disease. Ripe fruit in store-houses was more susceptible to rotting than unripe fruit in the field.

7. Immature fruit especially on the bunch with inflorescences still attached, was found to take the disease more readily than the mature fruit from which the inflorescences had already fallen.

8. It was found that the sweet varieties easily succumbed to the disease while those that were not so sweet were less subject to attack.

9. It seems that bunches having long rachis with the inflorescences growing closely were attacked by the fungus under favorable condition.

10. Dampness appeared to favor the growth of the organisms, for all inoculations carried on during rainy days had rapid and perfect development. This conclusion seems to be substantiated also by the fact that spores sown in a drop of water germinated rapidly.

11. Morphological study of the cultures showed that there was one general type of spores and mycelium, and that there was a slight variation in the size and shape of spores, depending upon the age. Younger spores seemed to be more rounded than the older ones.

12. In the physiological study of the organism, it was found that there was a slight difference in the manner of growth on the different media. However, the spores and mycelium produced in all cases were apparently identical in every respect.

13. In culture on the same medium the organism isolated from one host could not be distinguished from that isolated from another.

14. It was observed, especially on outside plantations that the fungus gained entrance through a wound on the rachis, which was due to the cutting off of the heart when gathered for food. In cases where the cut was made too close to the first "finger," the fungus easily made its way to the bunch.

15. Stems of diseased fruits were stunted and dried. All the leaves were drooping and shriveled.

RECOMMENDATIONS

The recommendations here given are based upon the results and observations.

1. In plantations where transportation facilities are hardest and marketing is difficult, sweet varieties or readily susceptible varieties should not be planted. Only the resistant or less infected varieties, like Litungdan and Sabas should be planted.

2. Great care should be taken in spacing the plants, the farther apart the plants are, the better. A distance of four meters between rows and four meters between plants is advisable for varieties which are readily infected, like Boñgolan, Lacatan, Tarnate and all sweet varieties. A distance of three meters by three meters is suitable for varieties which are less infected.

3. To avoid field infections susceptible varieties or the sweet varieties should not be planted side by side with resistant varieties.

4. The general cleanliness of the plantation should be maintained. No rotten fruit should be left on the ground for such material serves as a favorable medium for the fungus.

5. As apparently the foreign sweet varieties and some of the common native sweet varieties are most susceptible, planting of foreign sweet varieties should be abandoned and common native sweet varieties planted.

It is advisable to plant sweet varieties separate from the other varieties, preferably in another field.

6. Fruit should be stored in an ordinary, well ventilated room and never be piled in a dark corner. Fruit, especially the sweet varieties, should never be kept in jars to hasten ripening as is commonly practiced by the local "tenderas."

7. In order to avoid rapid contamination, sweet or susceptible varieties should not be mixed in storing, with the resistant varieties, whenever possible to avoid it.

8. Great care should be exercised in the gathering of the hearts. The rachis should not be cut close to the fruit and the cuts should be smooth and clean. To avoid it, hearts or fruits should not be gathered on rainy days.

9. Great care should be taken not to bruise the fruit when gathering it. Bruised fruit should never be stored with the sound fruit.

10. When storing the fruit it should be handled carefully in order to minimize the danger of bruises. Sharp bolos should be used in severing the fruit from the bundle.

11. The storeroom should be thoroughly cleaned before storing the fruit, for sanitation always prevents infection. Fruit that is attacked first should be immediately separated from the sound fruit to check the further spread of the disease.

12. Ants and other insects should never be allowed to crawl on the fruit as they are likely to convey the fungus.

13. Spraying the diseased fruit with Burgundy mixture is beneficial. In any work of this kind the results should be commensurate with the expense involved.

14. The fruit should never be harvested until it is mature. Immature fruit takes a long time to ripen, and it may be attacked by the fungus before it is fully ripe.

15. All fruit should be marketed as soon as it is ripe unless it can be kept under proper storage conditions.

16. Sweet varieties, like Boñgolan, Lacatan, Morado, Tarnate, Cavendish and others should never be kept over-ripe for they are readily infected. They must be disposed of as soon as possible.

17. It seems that the foreign sweet varieties and our common sweet varieties are susceptible to the disease, but if proper care be exercised in their culture and in handling the fruits the trouble may be reduced to a minimum.

ACKNOWLEDGMENT

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STORAGE OF SOME ROOT CROPS AND OTHER PERISHABLE FARM PRODUCTS[1]

By Domingo S. Baybay

INTRODUCTION

Among the products that are raised on the farm, roots, fruits, and vegetables are the ones which generally do not keep long; hence are called perishables. They are so susceptible to damage after they have been harvested that under ordinary conditions of handling and keeping they soon deteriorate and begin to decay. This is due to several causes, of which the principal are the fungi and other disorganizing agents induced by improper handling and lack of proper storage facilities. For this reason the study of some of the ways and means by which the life or marketability of these products could be prolonged is of great economic importance, for successful storage will help minimize the loss and waste along that line and make it possible for the farmer to hold over his produce to sell it to better advantage.

The experiment reported in this paper deals with a limited trial of storing some of the common perishable crops. The purpose was to find out, inside the time limit of this work and the available facilities, how long the products tested can be successfully held in storage by means within easy reach of the Filipino farmer.

This experiment was carried on in the College of Agriculture, Los Baños, and covered a period of about three months.

PREVIOUS WORK ON THE SUBJECT

Reyes, (1) found out that rots prevalent on agricultural products in storage and in the field are caused by *Diplodia*. He states that the same disease is responsible for much damage done on such important products as sweet potato, cassava, gabi, yautia, yams, cacao, patani, and maize. Sweet potatoes were found to be more readily attacked under Laboratory conditions than in the damp chamber. For this reason he recommended that with the possible exception of sweet potatoes, all roots, fruits, and tubers should not be kept in damp places as this condition seemed to promote decay.

For work done along this line in other countries, the following may be cited:

Church (2) in his article *A vanishing people of the South Seas*, mentions that bread fruit which is the principal food crop of the people of the Marquesas is stored by burying it by the thousands and tens of thousands in huge pits covered with a layer of earth. To quote, "Sometimes five years would elapse before necessity forced the king to lift the ban and open a given pit.

[1] Thesis presented for graduation from the College of Agriculture No. 139; Experiment Station contribution No. 82.

"By experience, it was discovered that even ten years did not destroy the buried bread fruit. The once green outer rind turned black, and the contents presented a white, somewhat mushy appearance, fermentation beginning immediately after it was broken open."

In Alabama, Carver (3) found that sweet potatoes dug and banked after a long dry period generally kept well, while those dug and banked after and during the rainy season almost without exception did not keep well. If the potatoes were cut or broken and the milky juice turned to dark greenish color when dried in the air they kept poorly, but if the juice dried white and showed a tendency to heal over, they kept well.

The Agricultural Gazette (4) of New South Wales reported that seed sweet potatoes were successfully stored by putting them in a box with alternate layers of dry fine sand.

Shiver (5) in his experiment with the object of determining the relative value of different methods of storing sweet potatoes of the Georgia Back variety, arrived at the conclusion that methods of storing largely influence the changes in composition of the roots.

According to Tracy (6) cassava may be kept in good condition for two months or longer if the roots are given the right treatment. A root which is always warm and dry will keep for a long period while one which is cold or wet will decay very rapidly.

MATERIALS AND METHODS

DESCRIPTION OF MATERIALS

Root crops.—Among the root crops used in this study were the following: gabi, ubi, sweet potato, tugui, yautia, and cassava.

(1) *Gabi* tubers were bought in the Calamba market on November 12, 1920. These were not washed. They were brought to the College ground in the College truck. A thick layer of dry rice straw was spread on the floor of the truck; on this the tubers were laid carefully. For protecting the roots from the intense heat of the sun another layer of rice straw about three centimeters thick was spread on top. Upon arrival at the College the roots were placed on a layer of rice straw on the cement floor of the Seed Laboratory and allowed to dry for eight days, before storing.

(2) *Ubi* tubers were obtained from the same source and treated in the same manner as the gabi.

(3) *Sweet potato* tubers of the variety Big Samar Yellow were obtained from the College Farm from an old culture which had been left in the field for furnishing cuttings. This material was dug on December 24, 1920. The harvesting was done by plowing the field and the roots which were not injured at all were saved for this experiment. The roots were not washed, but the soil clinging to the skin was removed by hand at the time of harvesting. The vines attached to the roots were cut off far enough from the tubers so as not to expose them to injury. The harvesting took place in good weather and soon after the harvest the roots were brought to the Seed Laboratory in a bamboo basket and dried in the shade for three days before storing.

(4) *Tugui* tubers (a species of Dioscorea) were grown on the College Experiment Station ground and were harvested when they were eight months old, counting from the date of planting. These were dug on December 2, 1920, for

exhibition purposes and great care was taken in handling them. The tubers were washed after harvesting. After they were exhibited for about two days they were left in the Seed Laboratory to permit them to dry for four days before placing them in storage.

(5) *Cassava* of the variety Mandioca Basiorao was grown on the College Experiment Station ground. The tubers were harvested when they were fourteen months old. The roots were dug with a native bolo and a spading fork. Only the unbruised tubers were used in this experiment. Immediately after harvesting, the tubers were brought to the Seed Laboratory and were allowed to dry in the open shed for eight days before storing.

(6) *Yautia* was grown on the College Experiment Station ground and the tubers were almost two years old when the material used in this experiment was dug. The yautia consisted of suckers, only. When harvested they were taken to the Seed Laboratory and placed under the middle part of the shed of the building for nine days to insure thorough drying.

Fruit.—The following kinds of fruit were used: pomelo, rough lemon, and chico.

(1) *Pomelos* at the time this experiment was carried out were very scarce. The writer could buy only a very limited quantity. The material here used was obtained from a small store in the barrio of San Antonio. Information received from the store-keeper stated that the pomelos were harvested in the usual way by shaking them off the tree with a long pole. As they fell to the ground with some force, they cracked. Those which were apparently not injured outside and were yellow in color were selected for use in this experiment. These were stored two days after picking.

(2) *Rough lemons* were harvested from the College citrus orchard. They were gathered from three trees, only. At the time of harvesting the fruit was just beginning to show yellowish coloration. The harvesting was done with the aid of a fruit picker made of wire. To lessen injury on the lemons the fruit pickers were lined with soft cloth which prevented the fruit from coming into direct contact with the wire. Those which were in some way bruised on the skin and those which were damaged by insects or fungi were not used. The material for the experiment was stored immediately after harvesting.

(3) *Chicos* were obtained in the barrio of San Antonio. They were harvested in the ordinary way, that is, by climbing the tree and picking them by hand. Only matured fruit as indicated by the brownish yellow skin was picked. The chicos were washed with tap water soon after picking. After drying in the air they were put in the storage rooms.

Vegetables.—The following vegetables were used: squash, radish, and endive.

(1) *Squashes* were obtained in the barrio of San Antonio. They were harvested January 24, 1921, and stored two days after. Only matured and sound squashes were used.

(2) *Radishes* were obtained in the Calamba market on January 27, 1921. Only tubers showing no injury on the outside were selected. These were washed with tap water. The tubers were put in a gunny sack and brought in a horse vehicle (*carromata*) to the College. These were stored two days after they were dug.

(3) *Endive* was harvested January 21, 1921, from the College garden when its general appearance indicated that it was fully developed for table use. The harvesting was done by pulling the whole plant from the ground. After the leaves were partly freed of moisture they were stored.

DESCRIPTION OF STORAGE STRUCTURES USED

Seed Laboratory.—A space in the north wing of the Seed Laboratory was used in storing the materials. Wooden racks are provided inside the room for holding receptacles, such as cans, grocery and mason jars, and bottles, in which seeds of different crops are stored. This laboratory has a galvanized iron roof and wooden ceiling. The floor is made of cement. The room is well ventilated by a continuous row of shell windows in three sides.

Dark room.—This room was in a small building, part of which had wooden walls, and part nipa walls, the roof was of nipa. The part with the wooden walls was used for the dark room.

Ordinary room.—The part of the same building with nipa walls was considered as the ordinary room. The floor is made of bamboo. The walls are raised from the surface of the grounds leaving an open space to admit air. For further ventilation a small wind in the upper part of the nipa wall was provided. The bamboo racks were also provided in this room.

Underground cellar with exposed roof.—A place on the left bank of the Molawin Creek near the lower nursery was selected for the location of the cellar. Bamboo trees grown on the upper edge of the bank above the cellar, and below right close to the cellar there is a big *Ficus* tree which with wide spreading branches heavily shades the cellar. The location and this shade make this particular storage unusually cool. The soil on the lower part of the bank is sandy loam and on the upper part is adobe rock. This rock on this particular portion of the river bank shows evidence of having been quarried in the pest, and as a result there was a hollow space. For purposes of the present work, in a portion of this hallow space, a pit was dug in August, 1920. The upper portion of the rock was left untouched for the supports of the framework of the structure. Dry bamboo pieces split into halves were driven close together along the side so as to prevent the soil from crumbling and falling down. The entrance was in the south end of the pit. The roof was made single pitch supported by a framework and posts made of dry stems of ipil-ipil. The roof was made of nipa. Racks placed along the west side were made of bamboo and those on the opposite side were made of wood.

Trench storage.—A trench was dug in a dry place under the roof of the upper nursery houses. The trench was made so that its sides slanted something like a bowl. It was three meters and a half long. The width was 60 centimeters at the top and 30 centimeters at the bottom. The bottom was moist; and to dry it out, it was found necessary to expose the cut surface for a few days before using the trench. Meanwhile, dry fine sand was piled near the trench ready for covering the roots to be stored.

Earthen vessels.—Four big earthen vessels, clean and dry, called locally *tinajas*, were buried to the neck in moist clay loam soil. This place was well shaded by a big tree which made the surroundings cool. The mouth of the jar was closed by covering it with a small sheet of tin cut from a petroleum can; the piece of tin was bent so as to prevent rain getting into the jar.

EXPERIMENTS AND RESULTS

PROCEDURE

In work, in foreign countries, on the subject of storing perishables, three main factors are considered, besides the type of storage structure and the condition of the fruit when placed in storage. Those factors are temperature, humidity, and aeration. In this experiment observation and records were taken on those factors in the different storages; namely, seed laboratory, dark room, ordinary room, and cellar. Livingstone white porous cups were used to determine the evaporating power of the air. These cups were standardized in the dark room before they were used. A thermometer was placed in each of the storage to record the temperature. As to aeration, no measurement was made except providing for the possible passage of air into and out of the structure through windows, vents, and other apertures found in them.

The material available of the different root crops, fruit, and vegetables used in this work was divided into as many groups as there were storing devices provided. The tubers were not graded at all, so there were in each group tubers of different sizes. The material was rather scarce at the time this work was undertaken; so the quantity was not sufficient to allow some being placed in each storage room.

The storing for each kind of product mentioned was done at one time in each storage room used. The material was gone over for bruises and other injury and while in storage it was examined from time to time and each lot was freed of spoiled stuff. The amount and weight of the materials in each lot, as well as the amount of spoilage and loss of weight by shrinkage, were determined and recorded at the beginning and at the end of the experiment. The number of roots that showed germination or sprouting were also counted, because while sprouting does not render the roots altogether useless, they are decreased in value.

Table I shows the distribution of the materials used under the different storages and the length of time in which each was kept in storage.

Seed Laboratory.—All the material in this storage were placed in separate single layers with the tubers set close to each other on wooden racks. This building was kept open daily from 6:00 a. m. to 6:00 p. m., except Sundays and holidays.

TABLE I.—*Showing distribution of materials and time they were kept in different storage structures*

Types of storage structures.	Materials.	Time kept in the storage.
	a. Root crops.	
	1. Gabi	Nov. 20, 1920--Feb. 20, 1921
	2. Ubi	Nov. 20, 1920—Feb. 20, 1921
	3. Tugui	Dec. 10, 1920—Feb. 20, 1921
	4. Yautia	Jan. 6, 1921—Feb. 15, 1921
	5. Cassava	Jan. 7, 1921—Feb. 1, 1921
Seed Laboratory	6. Sweet potato	Dec. 27, 1920—Feb. 20, 1921
	b. Fruit	
	1. Pomelo	Jan. 7, 1921—Feb. 20, 1921
	c. Vegetables	
	1. Squash	Jan. 26, 1921—Feb. 20, 1921

Types of storage structures.	Materials.	Time kept in the storage.
Dark Room	*a. Root crops.*	
	1. Gabi	Nov. 20, 1920—Feb. 20, 1921
	2. Ubi	Nov. 20, 1920—Feb. 20, 1921
	3. Tugui	Dec. 10, 1920—Feb. 20, 1921
	4. Yautia	Jan. 6, 1921—Feb. 15, 1921
	5. Cassava	Jan. 7, 1921—Feb. 1, 1921
	6. Sweet potato	Dec. 27, 1920—Feb. 20, 1921
	b. Fruit.	
	1. Chico	Jan. 14, 1921—Jan. 26, 1921
	2. Pomelo	Jan. 7, 1921—Feb. 20, 1921
	3. Rough lemon	Jan. 11, 1921—Feb. 20, 1921
	c. Vegetables.	
	1. Squash	Jan. 26, 1921—Feb. 20, 1921
	2. Radish	Jan. 29, 1921—Feb. 20, 1921
Ordinary Room	*a. Root crops.*	
	1. Gabi	Nov. 20, 1020—Feb. 20, 1921
	2. Ubi	Nov. 20, 1920—Feb. 20, 1921
	3. Tugui	Dec. 10, 1920—Feb. 20, 1921
	4. Yautia	Jan. 6, 1921—Feb. 15, 1621
	5. Cassava	Jan. 7, 1921—Feb. 1, 1921
	6. Sweet potato	Dec. 27, 1920—Feb. 20, 1921
	b. Fruit.	
	1. Chico	Jan. 14, 1921—Jan. 26, 1921
	2. Pomelo	Jan. 7, 1921—Feb. 20, 1921
	3. Rough lemon	Jan. 11, 1921—Feb. 28, 1921
	c. Vegetables.	
	1. Squash	Jan. 26, 1921—Feb. 20, 1921
	2. Radish	Jan. 29, 1921—Feb. 20, 1921
Cellar	*a. Root crops.*	
	1. Gabi	Nov. 20, 1920—Feb. 20, 1921
	2. Ubi	Nov. 20, 1920—Feb. 20, 1921
	3. Tugui	Dec. 10, 1920—Feb. 20, 1921
	4. Yautia	Jan. 6, 1921—Feb. 15, 1921
	5. Cassava	Jan. 7, 1921—Feb. 1, 1921
	6. Sweet Potato	Dec. 27, 1920—Feb. 20, 1921
	b. Fruit.	
	1. Chico	Jan. 14, 1921—Jan. 26, 1921
	2. Pomelo	Jan. 7, 1921—Feb. 20, 1921
	3. Rough lemon	Jan. 11, 1921—Feb. 28, 1921
	c. Vegetables.	
	1. Squash	Jan. 26, 1921—Feb. 20, 1921
	2. Radish	Jan. 29, 1921—Feb. 20, 1921
	3. Endive	Nov. 14, 1920—Nov. 21, 1920
Trench	*a. Root crops.*	
	1. Gabi	Nov. 20, 1920—Feb. 20, 1921
	2. Tugui	Dec. 10, 1920—Feb. 20, 1921
	3. Yautia	Jan. 6, 1921—Feb. 15, 1921
	4. Casssava	Jan. 7, 1921—Feb. 1, 1921
	5. Sweet potato	Dec. 27, 1920—Feb. 20, 1921
Earthen vessel	*a. Fruit*	
	1. Rough lemon	Jan. 11, 1921—Feb. 28, 1921
	b. Vegetable.	
	1. Radish	Jan. 29, 1921—Feb. 20, 1921

Dark Room.—In this room the materials were placed in the same manner as in the Seed Laboratory, but on bamboo slatted racks. The room was kept dark

by closing all holes and apertures were light might possibly get through. During clear weather, the windows were kept open at night for aeration and closed early in the morning and the room kept dark until about six o'clock in the evening.

Ordinary Room.—All the materials in this storage were handled in the same way as in the Seed Laboratory and dark room. For ventilation, a small window at the top in one end of the room was always kept open in addition to the open space left between the lower edge of the wall and the level of the ground. The open spaces where the nipa thatches and bamboo piece come together, always found in nipa and bamboo structures provides good deal of ventilation.

Underground cellar with exposed roof.—Before using this storage it was fumigated by closing all its open parts and burning dry bamboo trash inside to drive away insects and destroy with the flame, as much as possible, fungi and bacterial organisms which might have been present. After clearing the room of trash left by the fire for further disinfection a good amount of lime was spread all over the ground floor as well as on the sides. Then the different materials under trial were placed in the same way as in the other storages, with the exception of the endive which was set in seed flats with sand to let it continue growing. During good weather the small window in the roof was opened occasionally either at night or in the daytime as found convenient to let out the foul air inside.

Trench storage.—Only the different kinds of roots were stored in the trench, and they were kept separate from one another by means of a piece of board out so as to fit the sides across the trench. The tubers were placed in layers alternated with layers of dry sand about one centimeter in thickness.

Earthen vessels.—Rough lemons stored under this method were each wrapped with wood shavings. The radishes were put in a separate vessel. A piece of tin was used as cover for this receptacle.

RESULTS

Table II shows the daily average temperature in the different storages. As shown in the column of averages, variation in temperature caused a proportional variation in the water evaporated; that is the higher the temperature the greater

TABLE II.—*Showing averages of temperature, ventilation, and average daily evaporation from November 26, 1920, to February 19, 1921.*

Types of storage structures.	Average temperature readings.			Average temperature for the day.	Opening for ventilation per cubic meter of space.[a]	Average daily evaporation
	6 a.m.	1 p.m.	5 p.m.			
	°C.	*°C.*	*°C.*	*°C.*	*sq. m.*	*cc.*
Seed Laboratory	23.3	26.9	24.0	24.73	0.1636	17.807
Dark Room	22.2	26.2	25.5	24.63	0.1000	6.720
Ordinary Room	21.7	25.9	25.2	24.26	0.1333	6.215
Sellar	22.2	23.9	23.6	23.23	0.0061	1.081
Trench	No readings.					

[a] The opening for ventilation does not include the apertures found in the joining of nipa and bamboo on the sides as well as on the roof.

the evaporation. It is noticeable, however, that the variation in evaporation in the Seed Laboratory and in the Cellar is quite abrupt not only with respect to each other but also with respect to the evaporation in either the dark room or ordinary room. In these two rooms, the variation is very slight.

Root crops

Gabi.—The gabi was kept in the storages for ninety-two days and during this time decayed tubers were removed five times from each storage to reduce contamination to the minimum. It was observed that the greatest decay occurred during the early period of storing in each storage room. On the last day of the experiment, the dark room gave the lowest percentage of decay, 30.95, while the Seed Laboratory gave the highest, 66.42. Some of the diseased tubers were taken to the Pathology Department and it was found that *Diplodia* caused the rotting. The decay in all the tubers here used was mostly due to that organism. In the trench the loss was 44.75 per cent, next to the highest. The highest percentage of sprouted tubers was found in the dark room, but they did not develop roots as did the sprouted tubers stored in the trench.

Table III shows the results of gabi stored under the five different storages.

TABLE III.—*Showing results on gabi kept for ninety-two days in storage.*

Types of storage structures.	Amount stored Nov. 20, 1920.		Amount left February 20, 1921.				
			Sprouted.		Weight of good tubers.	Decay and shrinkage.	
	Number of tubers.	Weight of tubers.	Number of tubers.				
		kg.		*per cent*	*kg.*	*kg.*	*per cent*
Seed Laboratory...	216	18.2	40	18.50	5.10	12.1	66.42
Dark Room.....	248	16.8	122	49.19	11.60	5.2	30.95
Ordinary Room....	219	18.2	64	29.22	7.40	10.8	59.34
Cellar.....	318	29.9	134	42.13	11.68	18.3	61.20
Trench.....	395	30.5	170	43.03	16.85	13.65	44.75

Ubi.—Ubi, like the gabi, was kept for 92 days in the storages. Observation showed that in no storage was there decay. One tuber sprouted in the Ordinary

TABLE IV.—*Showing results on ubi kept for ninety-two days in storage.*

Types of storage structures.	Amount stored Nov. 20, 1920.		Amount left February 20, 1921				
			Sprouted.		Weight of good tubers.	Decay and shrinkage.	
	Number of tubers.	Weight of tubers.	Number of tubers.				
		kg.		*per cent*	*kg.*	*kg.*	*per cent.*
Seed Laboratory...	6	9.2			8.45	0.75	8.15
Dark Room.....	8	6.8			6.20	0.60	8.82
Ordinary Room....	11	8.8	1	9.09	8.15	0.65	7.38
Cellar.....	9	7.4			7.00	0.40	5.4

Room. In weighing the tubers on the last date of the experiment it was found that those kept in the dark room had lost the most weight, being 8.82 per cent, while the lowest loss, 5.4 per cent, occurred in the Cellar. Loss in weight due to the attack of fungi or shrinkage is considered under the same heading as decayed, or spoiled. Table IV shows the results of the trial.

Tugui.—This product did not appear to suffer from decay due to fungus attack. This condition suggested the advisability of not disturbing at all the roots buried in the trench until the close of the experiment covering a period of 72 days. The tubers in all the storages, except those kept in the cellar, presented a wrinkled appearance. The trench storage produced the highest percentage of sprouted materials, being 81.42. The lowest was in the Ordinary Room or 9.21 per cent. Table V shows the results of this product from the different storages.

TABLE V.—*Showing results on tugui kept for seventy-two days in storage.*

Types of storage structures.	Amount stored Dec. 10, 1920.		Amount left February 20, 1921.				
			Sprouted.		Weight of tubers.	Decay and shrinkage.	
	Number of tubers.	Weight of tubers.	Number of tubers.				
		kg.		*per cent*	*kg.*	*kg.*	*per cent*
Seed Laboratory...	88	9.50	11	12.79	6.00	3.50	36.80
Dark Room.....	75	10.20	20	26.56	7.30	2.90	28.43
Ordinary Room....	76	9.85	7	9.21	7.40	2.45	24.50
Cellar Room.....	71	10.00	12	16.95	8.10	1.90	19.00
Trench	70	9.60	57	81.42	7.35	2.25	23.43

Yautia.—Table VI shows the results from the tubers stored in the different structures for a period of 40 days. Most of the decay took place during the early part of the storing period. The decayed tubers were removed twice. The cause of the decay was not fungus but storage as characterized by its black powdery appearance on the skin. The highest percentage of loss in decayed and sprouted tubers was found in the trench, being 76.66 for the former and 78.4 for the latter. The lowest percentage of decay (56.41) was found in the dark room.

TABLE VI.—*Showing results on yautia kept for forty days in storage.*

Type of storage structures.	Amount stored Jan. 6, 1921.		Amount left February 15, 1921.				
			Sprouted.		Weight of good tubers.	Decay and shrinkage.	
	Number of tubers.	Weight of tubers.	Number of tubers.				
		kg.		*per cent*	*kg.*	*kg.*	*per cent*
Seed Laboratory...	227	17.50	19	8.37	4.00	13.50	77.14
Dark Room.....	243	15.60	31	12.75	6.80	8.80	56.41
Ordinary Room....	257	18.3	38	14.78	7.40	10.90	59.56
Cellar.....	207	17.6	53	25.60	7.10	10.50	59.65
Trench.....	180	17.60	138	76.66	3.80	13.80	78.40

Cassava.—Cassava was kept for only 25 days. The decayed tubers were removed four times at intervals of about six days. At the end of 25 days the cassava was removed from the storage and examined. The highest percentage of decay, 98.96 was found in the Seed Laboratory and the lowest, 63.96 found in the cellar.

TABLE VII.—*Showing results on cassava kept for twenty-five days in storage.*

Types of storage structures.	Amount stored January 7, 1921.		Amount left February 1, 1921.				
			Sprouted.		Weight of good tubers.	Decay and shrinkage.	
	Number of tubers.	Weight of tubers.	Number of tubers.				
		kg.		*per cent*	*kg.*	*kg.*	*per cent*
Seed Laboratory	29	22.90			0.30	22.60	98.69
Dark Room....	26	14.40			1.90	12.50	86.8
Ordinary Room.	23	15.40			1.20	14.20	92.20
Cellar.....	21	12.40			5.00	8.80	63.96
Trench.....	36	13.80			1.10	11.30	91.12

Sweet potatoes.—These roots were stored for 55 days. Within this period the decayed tubers were removed three times with an interval of twenty days between the first two inspections. At the close of the experiment it was found that the trench gave 30.45 the lowest percentage of decay and 45.00 the highest percentage of sprouted roots. The cellar gave 54.9 per cent of decayed roots and 14.24 per cent germinated roots. Each of the other storages gave less than two per cent of sprouted roots. The highest percentage of decay, 94.23, was found in the Dark Room.

The second highest, 84.95 per cent, was found in the Seed Laboratory. These results are shown in Table VIII.

TABLE VIII.—*Showing results on sweet potatoes kept for fifty-five days in storage.*

Types of storage structures.	Amount stored December 27, 1920.		Amount left February 20, 1920.				
			Sprouted.		Weight of good tubers.	Decay and shrinkage.	
	Number of tubers.	Weight of tubers.	Number of tubers.				
		kg.		*per cent*	*kg.*	*kg.*	*per cent*
Seed Laboratory	85	11.30	1	1.29	1.70	9.60	84.95
Dark Room....	95	10.40	2	1.11	0.60	9.80	94.23
Ordinary Room.	100	11.90	1	1.00	1.95	8.95	75.21
Cellar.....	70	10.20	10	14.24	4.60	5.60	54.90
Trench.....	100	13.10	45	45.00	9.10	4.00	30.45

Fruit

Chicos.—When these fruits were placed in storage they were mature and hard. Those stored in the dark room as well as in the ordinary room and in the cellar all ripened within four days in the storage. Thereafter as they advanced in ripening they become softer and softer until the end of twelve days when all the fruits were decayed.

Pomelos.—The pomelos stored in the cellar kept much longer than those that were placed in the dark room. After 40 days in the storage one fruit in the cellar was opened and tried; it was found fresh and of pleasant taste. Evidently the fruit became cured as the biting taste of the newly harvested pomelo was absent. The fruit in the dark room was also opened after 40 days; it was found to be rather dry as compared with the fruit stored in the cellar. These results are shown in Table IX.

TABLE IX.—*Showing results on pomelos kept for forty-four days in storage.*

Types of storage structures.	Amount stored January 7, 1921.	Amount left February 20, 1921.	
		Number of fruits.	Remarks.
Seed Laboratory	4	0	Fruits attacked by storage-rot fungus; dry.
Dark Room	4	3	Fruits shrunken; dry.
Cellar	4	3	Fruits good; fresh.

Rough lemons.—The results with rough lemons kept in the dark room, cellar and earthen vessel, at the end of 40 days, are shown in Table X. Out of 60 fruits stored in the dark room only one appeared to be decayed; but upon examination of the apparently sound ones, they were found desiccated and absolutely useless for eating. On the other hand, the fruits kept in the cellar and in the earthen vessel, which looked sound on the outside, were all found fresh. In the vessel, however, there was a greater number of lemons which became yellow in color than in the Cellar.

TABLE X.—*Showing results on rough lemons kept for forty days in storage.*

Types of storage structures.	Amount stored January 11, 1921.	Amount left February 20, 1921.	
		Number of fruits.	Remarks.
Dark Room	60	59	Fruits all dry, hard and wrinkled.
Cellar	60	58	Fruits fresh and good.
Earthen vessel	60	51	Fruits well cured and fresh.

Vegetables

Squash.—The squashes stored for 24 days in the Seed Laboratory, dark room, ordinary room, and in the cellar did not show any decay. However, at the end of 18 days storage in the Seed Laboratory, one fruit which was apparently immature had a wrinkled appearance, while another one in the Ordinary Room lost its green color. Those kept in the cellar remained crisp.

Radish.—The radishes which were kept in the dark and ordinary rooms were found dry at the end of eight days; but those which were kept in the cellar and in the vessel remained crisp in the storage for 21 days. However very few of the radishes in the two last named storages were edible because of the attack of rot.

Endive.—This vegetable after a week in the cellar practically lost its green color. Thus blanched it was tried for taste and found to be good and soft and free from the bitter taste which is imparted by the white sticky juice present in unblanched endive.

Table XI summarizes the results of the different root crops stored in the different storage structures.

Table XII shows the ventilation, temperature, evaporation, and average percentage of sound materials from the different storages.

TABLE XI.—*Summary of tubers sprouted and lost through decay and shrinkage in different storage structure.*

Materials.	Seed Laboratory.		Dark Room.		Ordinary Room.		Cellar.		Trench.		Length of storing period.
	Sprouted tubers.	Decay and shrinkage.	Sprouted tubers.	Decay and shrinkage.	Sprouted tubers.	Decay and shrinkage.	Sprouted tubers.	Decay and shrinkage.	Sprouted tubers.	Decay and shrinkage.	
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*days*
Gabi	18.56	66.40	49.19	30.95	29.22	59.34	42.15	61.20	43.03	44.75	92
Ubi	0	8.15	0	8.82	9.09	7.38	0	5.40	0	0	92
Tugui	12.79	36.8	26.66	28.46	9.21	24.50	16.95	19.00	81.42	23.35	72
Yautia	8.37	77.14	12.75	56.41	14.78	59.56	25.60	59.65	76.66	78.40	40
Cassava	0	98.69	0	86.80	0	92.20	0	63.76	0	91.12	25
Sweet potato	1.99	34.94	1.11	94.23	1.00	75.21	14.24	54.90	45.00	30.45	55
TOTAL	41.01	372.12	89.71	305.67	63.30	318.19	98.92	263.91	246.11	268.07	376
AVERAGE	6.83	61.02	14.95	50.94	10.55	53.03	16.48	43.98	49.22	53.61	62

TABLE XII.—*Showing ventilation, temperature, evaporation, and average per cent of sound materials from different storage structures.*

Types of storage structures.	Opening for ventilation per cubic meter of space.	Average temperature.	Average evaporation.	Average per cent of sound materials.
	sq. m.	*°C.*	*c.c.*	*per cent*
Seed Laboratory	0.1636	24.73	17.807	37.98
Dark Room	0.1000	24.63	6.720	49.06
Ordinary Room	0.1333	24.26	6.215	46.97
Cellar	0.2061	23.23	1.081	56.02
Trench	No readings			46.39

a The opening for ventilation does not include the operation found in the joining of nipa and bamboos on the sides as well as on the roof.

DISCUSSION OF RESULTS

EFFECTIVENESS OF DIFFERENT STORAGE

Root crops.—Assuming that more than 50 per cent spoilage is too large a loss for a successful storing under given conditions, the results, as recapitulated in Table XI, may be compared as follows:

In the Seed Laboratory where the average temperature is 24.73° C. and the average evaporation is 17.805 cubic centimeters with 0.1636 square meter of opening for ventilation per every cubic meter of storage space, the ubi gave a loss of only 8.15 per cent and the tugui 36.8 per cent loss in decayed and shrunken materials. The other materials gave, in varying figures, a loss in every case of more than 50 per cent.

In the dark room the gabi, ubi, and tugui sustained a loss of less than 50 per cent, while the yautia, cassava, and sweet potatoes gave a loss of more than 50 per cent. The conditions prevailing in this room as regards environment differ somewhat from the preceding type of storage as the opening for ventilation in only 0.1 of a square meter per cubic meter of space; 24.63° C. average temperature and 6.72 cubic centimeters of evaporation.

In the ordinary room only the ubi and tugui gave a percentage of loss less than 50, the environmental factors being a little more than 0.1333 of a square meter of opening for ventilation per cubic meter of storage space; 24.63° C. for the average temperature; and 6215 cubic centimeters for the average evaporation.

In the cellar, the ubi and tugui took the lead again where the environmental conditions were at their minimum rates, being 0.0061 square meter of opening per cubic meter; 23.23° C. average temperature; and 1.081 cubic centimeters average evaporation.

In the trench, the tugui and the sweet potato gave the best results, the sweet potato proving the better of the two. The environmental factors in this storage were not measured.

Subtracting the average percentages of loss of the different materials under each storage as shown in Table XI from one hundred per cent, the average percentage of sound materials obtained from each (Table XII) is as follows; Seed Laboratory, 37.98; trench, 46.39; dark room, 49.06; ordinary rooms 46.97; and cellar, 56.02. These figures included the percentage of sprouted stuff. They are self-explanatory, in so far as the comparative efficiency of the storage rooms is concerned.

As to the characteristics of behavior in storage of each of the materials used, the following observations are significant:

The gabi suffered the least amount of decay and shrinkage in the dark room. It gave the largest percentage of sprouted roots in the same room but without producing roots, while the sprouted tubers in the trench were accompanied with production of roots. The storing of these roots lasted 92 days.

For the same length of storing period, the ubi gave the most remarkable results. There were sprouted roots in the ordinary room but none in the Seed Laboratory and dark room; and while a spoilage was sustained in decay and shrinkage in all the rooms just mentioned, the losses ranged by small differences from 5.40 per cent to 9.09 per cent.

For a 72-day storing period, the tugui did not show any sign of decay, excepting two tubers found in the ordinary room. Practically all of the loss, therefore, was due to shrinkage. It is worthy of note that with the exception of the tubers in the cellar all those in the other storages presented a wrinkled appearance: so the lowest percentage of shrinkage was found in the cellar. As to sprouted roots, the ordinary room gave the lowest percentage and the trench the highest.

The yautia underwent a storing period of 40 days. The loss in the Seed Laboratory almost equalled that in the trench, the loss being much higher than 50 per cent. Likewise the loss in the ordinary room equalled that in the cellar by a smaller margin, the loss in either room being, however, considerably lower than 50 per cent. In contrast with the above results, the loss in the dark room differed by a wide discrepancy from that in the trench, the figure for each being higher than 50 per cent. In sprouted roots the Seed Laboratory recorded the lowest figure and the trench the highest. The dark room gave the lowest figure and the trench the highest. The dark room proved the best of all in efficiency.

In spite of the fact that the cassava underwent the shortest period of storing (25 days), it sustained a very high loss in every storage, ranging from 63.76 per cent in the cellar to as high as 98.69 per cent in the Seed Laboratory. As is commonly known the tubers of cassava never sprout, and it may be that as soon as they are severed from the mother plant they lose their vitality. It is perhaps due to this phenomenon that the cassava showed the poorest keeping quality and an extreme susceptibility to disease. In fact the slightest injury on the tubers, as was made apparently by rats in the storage, was invariably immediately followed by fungus attack and rapid decay. Nevertheless the smallest loss in the cellar, although higher than 50 per cent, suggests the possibility of a better result with a more suitable storage.

With the exception of tugui, the sweet potato kept in the trench better than any of the other materials, with the minimum loss of 30.45 per cent in a storing period of 55 days. The losses in the other rooms were greater than 50 per cent

ranging from 54.9 per cent in the cellar up to as high as 94.23 per cent in the dark room. A small part of this damage was due to ravages of rodents; but most of it was caused by the storage rot fungus. Evidence of this disease was even found under the skin of wrinkled roots which did not show the attack of the disease on the outside. In sprouted tubers the Seed Laboratory, dark room, and ordinary room gave less than two per cent, while the cellar gave 14.24 per cent and the trench 45 per cent.

FRUIT

In regard to chicos, it appears that they cannot be successfully stored more than five days in the ordinary room, dark room, and cellar which were the only rooms used for them. At the end of that period of time the fruit began to decay, showing that the conditions prevailing in those rooms did not check the development of disorganizing agents that affected the fruit.

With respect to pomelos, the cellar proved to be the best storage for them as compared with the Seed Laboratory and dark room; these three rooms were the only ones used for these fruits. It is very probable that the lower temperature prevailing in the cellar was largely responsible for keeping the oranges in good shape for a period of 44 days. It is because the temperature and evaporating power of the air in the two last mentioned storages were much higher than in the cellar.

As to the rough lemons, the cellar again gave a better record than the dark room or *tinaja*, or earthen vessel. In the dark room the lemons were all rendered useless by desiccation and in the *tinaja* nine were lost by decay while in the cellar only two fruits were lost. The storing period was 40 days. The losses may be attributed to the air being warmer in the dark room than in the cellar and to lack of ventilation in the *tinaja*, which was kept covered for the whole length of the storing period.

VEGETABLES

The squashes were kept only in the Seed Laboratory, dark room, ordinary room and cellar and the radishes in the dark room, ordinary room, cellar and jar. In both instances the cellar proved to be the most efficient storage.

The result with the endive stored in the cellar for one week was the one expected, the bleaching of the vegetable. This phenomenon is known to occur with endive as well as with other vegetables like lettuce, celery, pechay which keep alive in dark storage when properly placed.

Interpreting some of the facts discussed above it may be said that the different kinds of materials used in the present test differ, in their inherent keeping qualities. Also these qualities are affected by the character of the storage structure as well as by conditions obtaining in it. It is to be noted that the storage rooms used were not so constructed as to enable the writer to control those conditions so as to make them amenable to what might have been the requirements of each material. In fact the factors which have to do with the effectiveness of storage, such as temperature, humidity or evaporation, and aeration were practically left to the natural adjustment in the different storage structures. For two reasons the writer made no attempt to modify the conditions. First, because the facilities available did not permit his doing it; and second because his intention was to approximate storage possibilities on the ordinary farm. There is no doubt

that much better results might have been secured from this experiment with more suitable storage structures and with a better means of controlling the conditions in the storages.

SUMMARY OF CONCLUSIONS

1. Gabi was successfully stored in the dark room for 92 days.
2. Ubi had the best keep quality of all the root crops used. This kept best in the cellar for 92 days.
3. The tugui was successfully kept in the cellar for 72 days.
4. With the yautia 56.41 was the lowest percentage of loss in 40 days storage in the dark room.
5. Cassava cannot be kept long in any of the storage rooms. The lowest percentage of loss in 25 days was 63.96 in the cellar.
6. The sweet potato kept best in the trench for a period of 55 days with 30.45 per cent as the lowest percentage of loss.
7. Comparing the average percentage of loss of all the materials used under each storage room, the cellar was found to be the most efficient, the dark room ranking second.
8. The highest percentage of germinating tubers, except the ubi, was found in the trench.
9. The chicos began to decay after five days in the storage rooms used.
10. Pomelos and the rough lemons were successfully kept for 44 and 40 days respectively in the cellar. The lemons stored in the earthen vessel cured more uniformly than those in the cellar.
11. Squash stored in the cellar for 24 days remained fresh.
12. The radishes did not dry in the cellar at the end of 21 days but weer greatly damaged by storage rot fungus.
13. The endive continued growing and was successfully blanched in the cellar in seven days.

RECOMMENDATIONS

1. The writer recommends that roots or tubers intended for storing should be neither immature nor over-mature. They should be harvested at the proper age.
2. The utmost care should be exercised in harvesting roots, fruits and vegetables for storing. Bruises and other injuries should be guarded against as they always invite disease.
3. Roots for storing should be harvested only during good weather. They should not be washed.
4. An under-ground cellar with proper ventilation is to be recommended for storing roots, oranges, and lemons and some vegetables like the squash.
5. Abandoned farm houses should be utilized as storage houses on the farm.
6. Tubers should be air-dried before storing them.
7. The trench is to be recommended for storing roots, especially when intended for seed purposes.

ACKNOWLEDGMENT

The writer is greatly indebted to Prof. Inocencio Elayda under whom this work was carried out for his valuable suggestions and advice, to Prof. Otto A. Reinking for the identification of the disease organisms and for his criticisms. Thanks are also due to Dr. Rafael B. Espino for standardizing the atmometers.

NOTE ON EFFECT ON BANANA FRUIT OF PREMATURE APPEARANCE OF THE INFLORESCENCE[1]

By Frank P. McWhorter
Of the Department of Plant Physiology

In the January number of *The Philippine Agriculturist* Doctor Mendiola describes an interesting case of the premature appearance of the inflorescence in the Lacsoloi variety of banana. An accident caused the premature exposure of the inflorescence. Doctor Mendiola points out two important peculiarities presented by the mature spike: 1) Very short internodes between the "hands". 2) No normal space between the normal fruits and those that would have been the last or secondary fruits. I wish to point out that the early exposure to light may be largely responsible for the changes produced. It is well known that light produces a marked formative effect on any plant or plant organ. In general it may be stated that the longer the exposure to light of a developing organ, the shorter the internodes. A familiar example of this is the comparative lengths of the nodes of potato shoots grown in the light and in the dark. Early exposure of the inflorescence necessitates increased exposure to light at a time when the organ is in a critical period of formation. Hence it may well be reasoned that at least part of the changes noted by Doctor Mendiola may be traced directly to the light relation.

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[1] Mendiola, A. R. Effect on banana fruit of premature inflorescence. Philippine Agriculturist 10: 259-263. 1922. One plate.

ABSTRACTS[1]

The effects of salts added to the soil in pots upon the growth of roselle plants and production of fiber, CAMILO C. GUEVARA (*Thesis presented for graduation from the College of Agriculture, No. 140; Experiment Station contribution No. 83*).—The object of this experiment was to find approximately the salt requirements of the roselle plant. Three or four fertilizer salts, mono-potassium phosphate (KH_2PO_4) calcium nitrate ($Ca(NO_3)_2$) magnesium sulphate ($MgSO_4$) and Ammonium sulphate ($(N.H_4)_2SO_4$) were used in different proportions.

The fertilizer salts applied in all cultures seemed to have taken effect as early as about one week. The presence of ammonium sulphate ($(NH_4)_2SO_4$) seemed responsible for the deep green tint of the leaves which indicated vigor and rapid growth of the plant. With a few exception the fertilized cultures may be considered medium in value. This showed either that the best culture medium was not found or that the soil used does not absolutely need any fertilizer.

High application of mono-potassium phosphate (KH_2PO_4) and magnesium sulphate ($MgSO_4$) was found unfavorable to the development of the roselle plant and its fiber. But relatively high amounts of calcium nitrate ($Ca(NO_3)_2$) with low amount of mono-potassium phosphate and magnesium sulphate ($MgSO_4$) gave a favorable growth of plant and high yield of fiber. It is also shown that the addition of ammonium sulphate to the three salts used was favorable to the growth of the plant and the production of fiber.

—*Abstract by Euligio C. Ureta.*

Comparative culture of upland and lowland rice with special reference to cost of production and distribution of income. FLORENTINO RAMOS (*Thesis presented for graduation from the College of Agriculture, No. 141, Experiment Station Contribution No. 84*). The work reported by Mr. Ramos included observation of rice farming, upland and lowland, in the barrios of Batong Malake, Amos, San Antonio, Maahas in the municipality of Los Baños in 1919-1920 and the running at the same time, side by side, a lowland and an upland culture of rice on the College Farm. His object was to compare upland and lowland rice culture with special reference to cost of production and distribution of income.

The fields observed in the barrios were run on the share arrangement between the tenant and the landlord. The landlord furnished the land and the seed and paid the land tax, and the tenant paid all other expenses required to raise the crop. The gross income from the crops was divided half and half between the landlord and the tenant, after deducting twenty per cent of the crop for the harvesters' wages.

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[1] Abstracts prepared as part of required theme work in English 101 College of Agriculture.

Mr. Ramos made records of the actual number of hours, labor, and expends alloted in different cultures. The methods, tools, implements and work animals commonly employed by Filipino farmers were used.

The varieties used for upland were Quinastila and Inintiw; both required 126 days from planting to harvesting. For lowland, Macan Masinsin, requiring 139 days and Binangbang, requiring 144 days from planting to maturity, were used.

The following table is the summary of the yield, costs, and income per hectare gathered from the extensive tables presented in the thesis:

Culture.	Actual yield per hectare.	Landlord.			Tenant.		
		Gross income per hectare.	Cost of production per hectare.	Net income per hectare.	Gross income per hectare.	Cost of production per hectare.	Net income per hectare.
upland.	*cavans.*	*pesos.*	*pesos.*	*pesos.*	*pesos.*	*pesos.*	*pesos.*
Batong Malake	22.14	94.10	23.17	70.93	94.10	62.25	31.85
Anos	28.50	121.12	27.23	83.89	121.12	74.70	46.42
San Antonio	24.70	104.97	21.83	83.14	104.97	75.97	29.00
College	11.54	49.04	18.03	31.01	49.04	131.12	—81.08
lowland.							
Maahas	19.60	83.20	13.26	69.94	83.20	124.36	—41.16
College	36.84	156.57	33.85	122.72	156.57	227.03	170.46

From the above results, Mr. Ramos made these conclusions:

1. The upland cultures outside the College gave a higher yield than the lowland.
2. It costs less to raise upland rice than the lowland per unit area.
3. Both the landlord and the tenant in Batong Malake, San Antonio and Anos made a gain, Anos leading. The tenant from Maahas in lowland crop made no profit at all.
4. In the four barrios the gross income of the tenant and landlord was the same.
5. The tenant in Anos who made the least number of plowings and harrowings made the highest income because his labor cost for cultivation was less per unit area than the other tenants.
6. The College lowland culture gave a higher yield than the upland culture. The tenant in the College lost while the landlord gained.

—*Abstract by Pedro A. David.*

COLLEGE AND ALUMNI NOTES

Mr. D. A. Herbert arrived in the Philippine Islands on the *Tango Maru* on February 13 and immediately assumed his position as head of the Department of Plant Physiology. Professor Herbert holds the degree of M. Sc. from the University of Melbourne. He had an extensive experience as Botanist and Plant Pathologist of Western Australia before coming to the Islands.

The College of Agriculture Alumni Association has been incorporated. Messrs. Rodrigo, Divinagracia, Collado, Manza, Pañganiban, Reyes, Agati, Alas, Goco, and Espino were chosen incorporators. The Board of Directors is composed of Dr. R. B. Espino, President; Mr. G. Francisco, Vice-President; Mr. Vicente Aldaba, Secretary; Dr. N. B. Mendiola, Treasurer; and Prof. M. A. Roa, Member.

Prof. Irving Leonard of the Engineering Department and Mrs. Leonard sailed March 10 for the United States. Both faculty and students of the College deeply regret that Professor Leonard, acting on his physician's advice, is leaving the Philippines permanently.

Mrs. Leonard, though not actively connected with the College, by her active social work, made an enviable place in her brief stay, in the College Community. The Christian Endeavor Society passed resolutions expressing in warm terms the appreciation by the society of Mrs. Leonard's work in the organization.

A letter received by Mr. Deogracias Villadolid brings news of Mr. Joseph A. Cocanneour, M. S. '18, U. P., formerly in the Department of Agronomy of the College of Agriculture. He is now in Chowchilla, California. His letter in part is as follows:

> I suppose you wish to learn about myself. I am developing my ranch which is slowly growing into a fine fruit farm. I am planting forty acres in grapes, plums and peaches . . . . I have, besides, my experiment grounds where I have planted nearly one hundred varieties of choice fruits. I am also principal of the High School here . . . . My most important position is that of scientific adviser for the California Nurseryman's Bud Selection Association. During the summer the association takes all my time. Then, besides all this, I usually deliver several lectures a month in the state on various agricultural subjects. So you see I am what might be considered a busy man . . . . .

The following, from a letter from Doctor Trelease of the Laboratory of Plant Physiology, Johns Hopkins, carries its own comment:

> Will you please have the College Cooperative send to me, with bill, 20 copies of the Preparation of theses and other manuscripts by Trelease and Yule. Dr. J. W. Shive, Professor of Plant Physiology at Rutger's College, wants about a dozen copies, one for each man in his laboratory.

On the evening of March 16 the Senior Class gave a *despedida*, in the form of a banquet in Los Baños, to Dean Baker, Professor Emma S. Yule, and Doctor Mirasol. Mr. Peña was toastmaster. Mr. Baltazar of Class '22, and the guests of honor responded to toasts. The occasion was marked by a friendly informal atmosphere that make such gatherings remembered with pleasure.

RESOLUTIONS OF CONDOLENCE

Whereas, by the departure of Agapito Fello to the Land of an Endless Rest, the Class of 1922 of the College of Agriculture, University of the Philippines, lost one of its active members; and

Whereas, the untimely death of Agapito Fello, which took place in Indang, Cavite, on February 16, 1922, served his association with us; and

Whereas, his refined nature, manly upright character, and studious habits always commanded our respect and won our affection; therefore be it

Resolved that we, the members of the Class of 1922 of the College of Agriculture, University of the Philippines, do hereby express our heartfelt sorrow and deep regret for his death; and be it further

Resolved that we extend our sympathy and condolence to the bereaved parents, sisters, and relatives in their sorrow; and be it further

Resolved that a copy of these resolutions be sent to the parents of the deceased; and that copies thereof be published in the *Philippine Agriculturist* and in the *Third Plow*.

The Committee on Resolutions

ANACLETO R. PELIÑO, *Chairman.*
VENERANDO P. MARILAO, *Member.*
BASILIO O. VIADO, *Member.*

Dated at the College of Agriculture, Los Baños, Laguna, Philippine Islands, this twenty-fourth day of February, Nineteen Hundred and Twenty-two.